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A STUDY OF ELECTRICAL ENGINEERING GRADUATES

R. G. KLOEFFLER, *Professor and Department Head of Electrical Engineers, Kansas State Agricultural College*

During the college year 1928–29, a study was made of the type of work, the progress, and the salary of the graduates in Electrical Engineering at the Kansas State Agricultural College. This study was made through the medium of a questionnaire which was mailed to all graduates of the classes of 1915 to 1927 inclusive.

The usual response to questionnaires sent to college graduates covers only about 10 to 15 per cent of those addressed. The sponsors of this project believed that a return from a small percentage of those addressed might represent the ones who had been most successful, and that the conclusions drawn from such replies would give an over-optimistic picture when applied to the entire group under consideration. In this study a series of follow-up letters was mailed out until replies were received from 85 per cent of the entire group. The members of the class of 1928, whose positions and salaries were known were included in tabulations and curves, though no questionnaires were mailed to them. The study covers a net group of 302 graduates.

A key number was assigned to each graduate and this number was placed upon the questionnaire when mailed out so that no one who later made any analysis of the replies would know the name of the individuals concerned. The names represented by the key number were held in secret by one person who had charge of mailing out follow-up letters, and of the task of obtaining scholarships and intelligence test records.

Income or salary is not the proper basis for judging the true worth and success of any individual in life; yet it is one basis which can be applied to a large group of individuals and, unfortunately, it is the criterion by which many Americans are inclined to judge their fellowmen.

The questionnaires returned from the first letter sent out

covered about 40 per cent of all that were ultimately secured. Strangely enough, all of the graduates having the highest salaries replied to the first letter of request. The follow-up

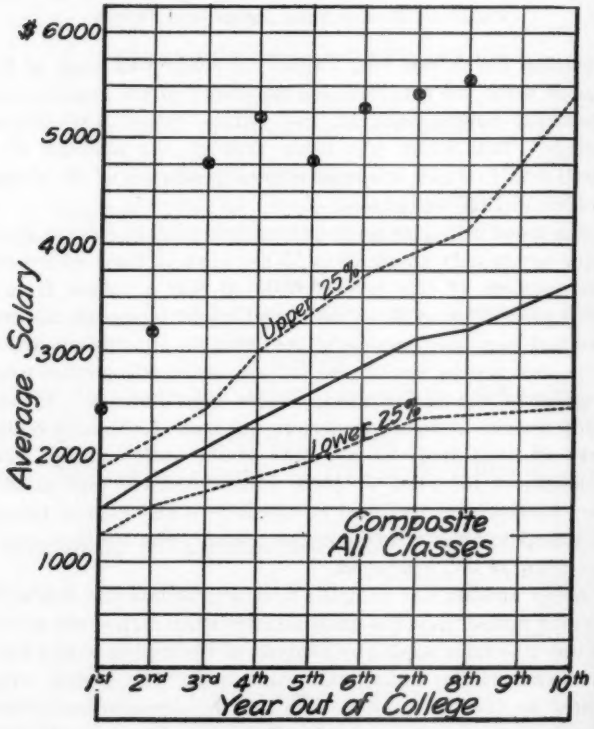

FIG. 1.

letters brought in the questionnaires showing more of the average of lower salaries.

The information supplied by the questionnaires has been used to plot curves showing the increase of salary or professional income. The curve of most general interest is the composite for all classes as given in Fig. 1. The heavy line of this figure shows the average salary of three classes for

each year. Thus, year 1 gives the average of classes 1928, 1927, and 1926 during their first year out of college; year 2 for classes 1927, 1926, and 1925 for their second year out of college, etc. This particular plan of taking averages was found necessary because the initial salary of college grad-

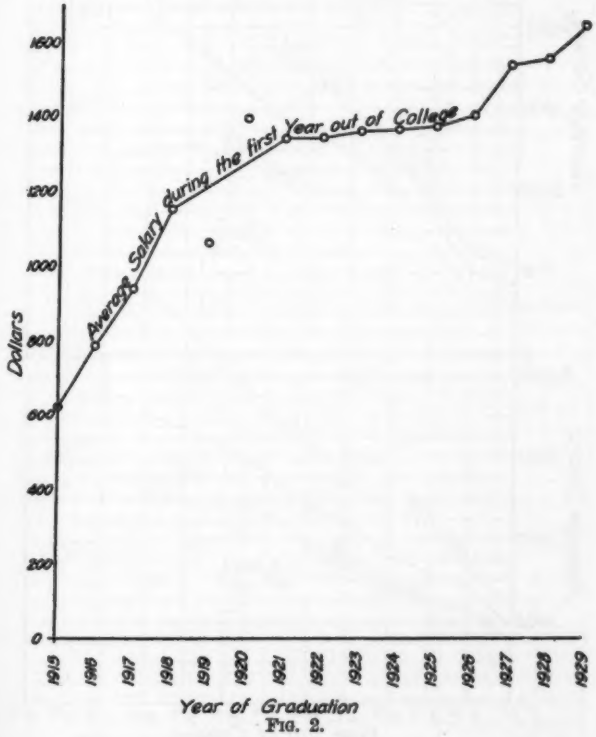

FIG. 2.

uates has been much higher in recent years, and because some classes were small or abnormal in some way. Curves are also shown for the average of those in the upper 25 per cent of the group in salary and for the average of those in the lower 25 per cent of the group in salary.

Twenty-five per cent was chosen instead of ten per cent because some classes were small and here 10 per cent meant the

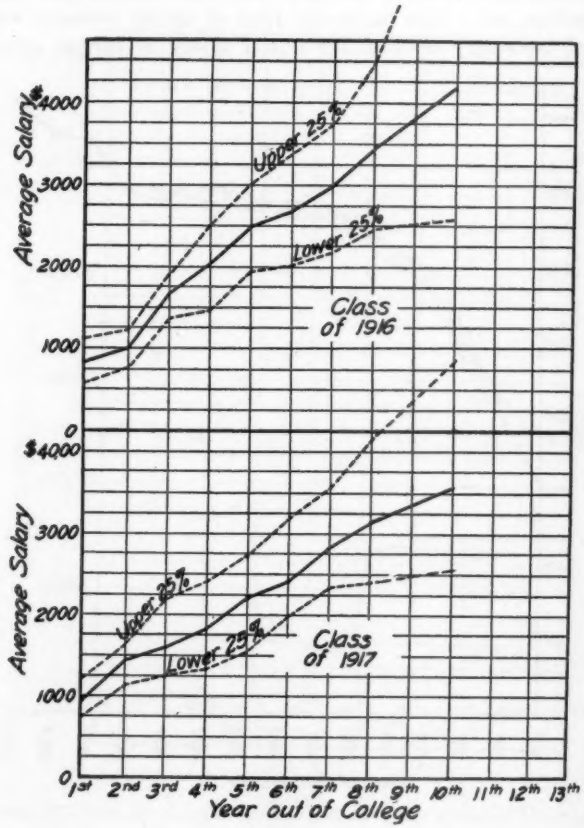

FIG. 3.

salary of two or three individuals and would not give a representative curve. The crosses in the upper part of this curve represent the peak individual salaries received.

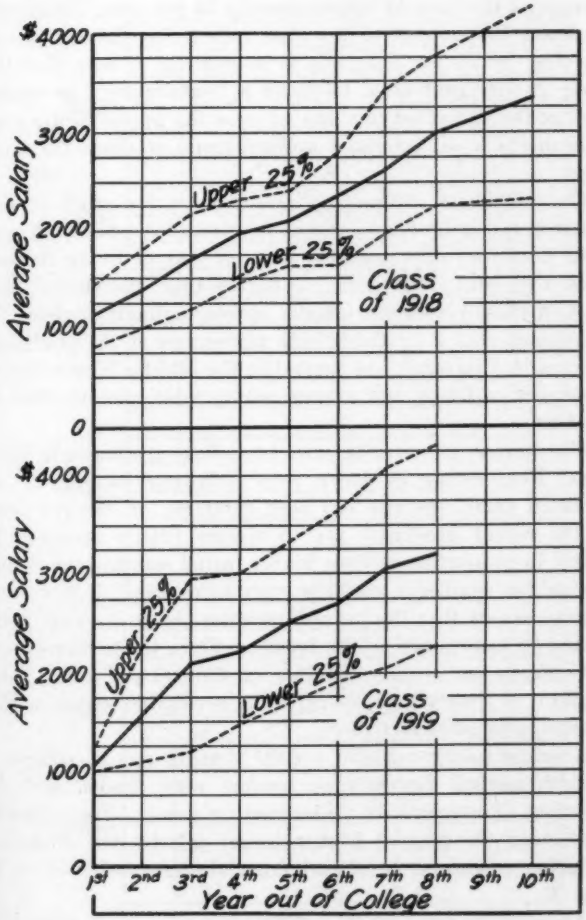
$4000
3000
2000
1000
0
Average Salary
Upper 25%
Lower 25%
Class of 1918
$4000
3000
2000
1000
0
Average Salary
Upper 25%
Lower 25%
Class of 1919
1st 2nd 3rd 4th 5th 6th 7th 8th 9th 10th
Year out of College

FIG. 4.

The upper 25 per cent of the class in salary exceeds the average of the class by approximately 33 per cent. Similarly the lower 25 per cent of the class falls below the average of the class by 25 per cent. It is interesting to note that the lower 25 per cent seem to reach a "saturation" in salary level at the end of seven years whereas the upper 25 per cent seem to reach an accelerated upward trend at about the same time.

The salaries of engineering graduates as for other professional men usually have a direct relation to the cost of living. Thus it is generally conceded that the cost of living in New York City and Boston, etc., is higher than elsewhere. Salaries in these places are usually correspondingly higher. It so happens that a relatively high percentage of the graduates covered by this study are located in the Middle West where a lower cost of living and a lower salary scale prevails than in the East.

The increase in initial salaries for college graduates in Electrical Engineering is shown very strikingly in Fig. 2. In fourteen years, the rise has been $1000.00, or 150 per cent. If the recent graduates are to receive future increases in salary in proportion to their higher initial salaries, the future income for engineers would be very attractive. It is reasonable to expect that the yearly increases shown by past years should be maintained in the future. Thus, the earlier classes have shown an average increase of $300.00 per year. This amount of yearly increase gives a predicting equation for present graduates as follows:

Average salary $= \$1650 + \$300 \times$ years out of college.

Mathematical figures may become very elusive and the juggling of averages is an interesting game. For example, neglecting the present higher initial salaries the following equation might be developed from the composite curve of Fig. 1.

Average salary $= \$1500 + \$250 \times$ years out of college.

The salary trend of individual classes is shown in Figs. 3, 4, 5 and 6. The one interesting thing shown by the curves of these figures is the rapid divergence of both the upper 25 per

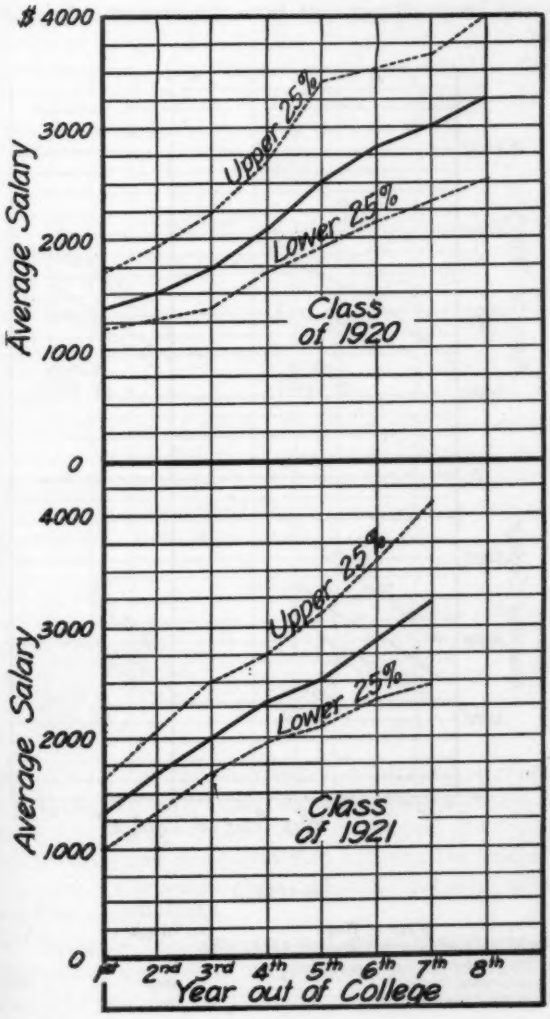
$ 4000
3000
2000
1000
0
Average Salary
Upper 25%
Lower 25%
Class of 1920
4000
3000
2000
1000
0
Average Salary
Upper 25%
Lower 25%
Class of 1921
1st 2nd 3rd 4th 5th 6th 7th 8th
Year out of College

FIG. 5.

cent and lower 25 per cent from the average salary of the group.

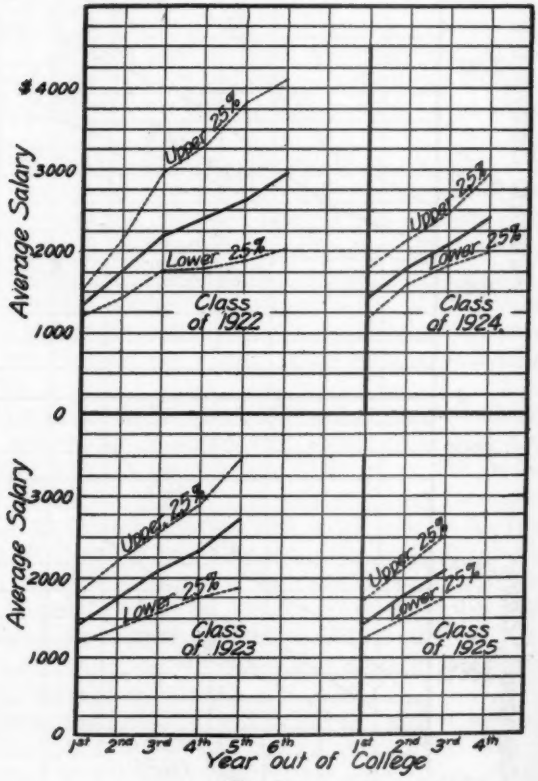

FIG. 6.

TABLE I

Type of Work	5 Years Out of College	10 Years Out of College
Technical Engineering—Design, Application, Production	63%	47%
Commercial (Sales)*	30%	39%
Non-Engineering	7%	14%
	100%	100%

* Includes sales in non-engineering fields.

The information supplied by the questionnaires permitted an analysis of the distribution of graduates in regard to type of work pursued. Thus, the data of Table I show the distribution of graduates in technical, commercial, and non-electrical work, after 5 and 10 years of service.

TABLE II

Type of Work	Salary 5 Years Out of College	Salary 10 Years Out of College
Technical Engineering—Design, Application, Production	100%	100%
Commercial (Sales)*	99.5%	106%
Non-Engineering	85%	71%

* Including sales in non-engineering fields.

Similarly, Table II shows the distribution of salary for this same classification of work. Contrary to the usual conception, the salesmen for the group studied did not receive a much higher compensation that the men in technical work. The engineers who entered the non-engineering field did not fare as well as their classmates.

TABLE III

Employer	5 Years Out of College	10 Years Out of College
Electrical manufacturer	34%	28%
Electric power company	37%	28%
Communication—Telephone, Radio	14%	16%
Miscellaneous	15%	28%

Table III gives the distribution of graduates among the usual fields of employment. The percentages shown in this table will not apply to the classes of the past three years because of the larger number of men entering the field of communication. For recent classes, about 30 per cent enter each of the three major fields.

The study of the questionnaires shows that 5 years after graduation 40 per cent of the graduates are in executive positions, and that after 10 years the percentage is increased to 64.

The data secured by the questionnaires and from other sources permitted a study of the correlation between the salaries received and

1. Scholarship,
2. Extra-curricular activities,
3. Self-support of students,
4. Mental ability as shown by intelligence tests.

For each class the average salary was plotted for those in the upper 25 per cent in scholarship and similarly for those in the lower 25 per cent in scholarship. For some classes those having the highest scholarship received the highest salary. For other classes the reverse was true, and for still other classes the lines would cross two or three times over a ten year period. Hence, there was no positive correlation shown between salary and scholarship. While this result may be disappointing it is not difficult to explain. Scholarship in itself is only one of the factors which makes for success in life. The practicing graduate naturally gravitates to the position in life where he is most happy, and where his qualifications are most useful. As this process takes place each individual will find himself in a position which he can fill successfully in accordance with his ability and with a corresponding salary. This method of reasoning will not apply to a particular industry or a particular branch of an industry where the work tends to be technical rather than commercial.

The studies made upon the relation between salaries and extra-curricular activities, self-support of students and mental ability (intelligence test results) likewise showed a lack of positive correlation. These studies, however, did show a very high correlation (.85) between scholarship and the mental ability as shown by the intelligence tests.

REPORT OF TEACHING LOAD SURVEY OF THE ENGINEERING DIVISION, IOWA STATE COLLEGE

M. P. CLEGHORN, *Professor of Mechanical Engineering*

In the fall of 1927 the Efficiency Committee of the Engineering Division, of which committee the author was chairman, was assigned the task of making a survey of the division with the purposes in mind of: 1st, determining the teaching load of the various members of the engineering faculty; 2nd, comparing the various departments as far as teaching load was concerned; 3d, determining, if possible, some means of computing the teaching load of an instructor.

Teaching Load

In order to determine the load on each man, questionnaires were sent out each quarter of the year 1927–28 to each member of the division. A copy of the questionnaire is herewith presented. It will be noted that the questionnaire asked for the number of clock hours per week spent on the following lines of work: Student conferences; official meetings; executive and office; research; professional improvement; total hours. Each man was requested to keep a diary of his time for a representative week as a basis for his reply. It was realized however that one week would be insufficient for some items and in such cases the men were asked to estimate their time over a larger period. While there is some chance of error in the estimated return, the men were conscientious and it is felt the answers represent fairly well the division of time.

The information thus obtained was carefully scrutinized, tabulated, and grouped according to department, and also according to rank of the men. The hours per week for all men in the same rank were then averaged for each department. Those averages are tabulated on sheet marked Plate I. The

teaching time includes the time in classroom or laboratory, time for preparation, and time for grading the work of the students.

This tabulation is nearly self-explanatory. It shows not only the average hours per week for the year in every case

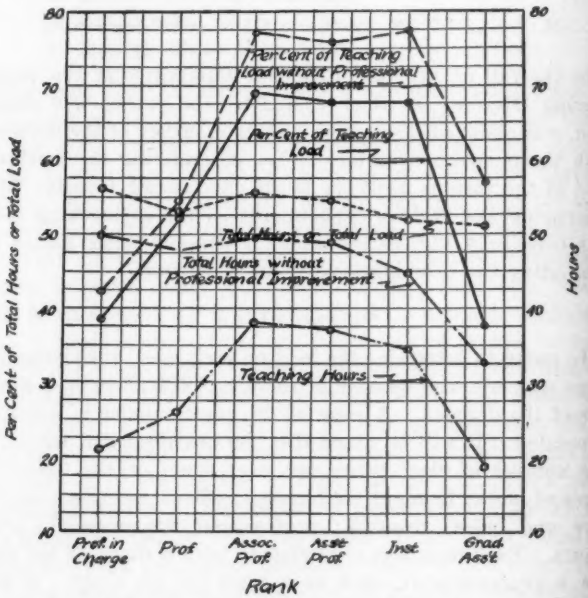

PLATE II. Study of Teaching Load and Total Load for Teaching Staff of Engineering Faculty, Iowa State College.

but the maximum and minimum values used in the average. It may be noted that the total per week in most cases is well above fifty hours. In fact, the grand average of all total hours is 53.6 hours per week or 9.73 hours per day, counting five and one-half days per week. In this regard attention is called to a similar survey made by the department of Electrical Engineering at the State College of Michigan during this same year 1927–28. A report of this survey appeared in the

Withdrawn

Rank		Agricultural Engineering			Architectural Engineering			Ceramic Engineering			Chemi Engine	
Professor in Charge	Student Conference	3.0	3.0	3.0	0	1.6	3.0	0.5	4.5	12.0	4.0	7.0
	Official Meetings	3.0	3.0	3.0	0	1.6	3.0	1.0	2.0	3.0	1.0	1.0
	Executive & Official	3.0	4.3	7.0	18.0	21.0	25.0	18.0	19.0	25.0	8.0	11.6
	Research	12.0	13.3	14.0	0	4.3	10.0	0	6.6	20.0	4.0	5.6
	Prof. Improvement	1.0	9.6	14.0	4.0	4.6	5.0	10.0	11.6	13.0	2.0	5.6
	Teaching Hours	17.5	24.3	28.5	19.0	22.6	25.0	7.0	10.1	13.0	20.0	24.3
	Total Hours		57.5			55.7			53.8			55.1
Professor	Student Conference	2.0	2.0	2.0								
	Official Meetings	2.0	2.3	3.0								
	Executive & Official	10.0	14.0	16.0								
	Research	2.0	4.7	10.0								
	Prof. Improvement	0	2.3	4.0								
	Teaching Hours	22.0	23.5	28.0								
	Total Hours		48.8									
Associate Professor	Student Conference	1.0	2.5	4.5	0.3	0.4	1.0				1.0	1.3
	Official Meetings	1.5	3.2	5.0	0	0.9	2.0				1.0	2.3
	Executive & Official	6.0	7.0	10.0	1.0	1.7	3.0				5.0	5.5
	Research	0	0.8	5.0	0	0	0				0	3.3
	Prof. Improvement	0	5.0	10.0	10.0	13.6	20.0				5.0	5.0
	Teaching Hours	27.0	31.5	40.0	28.0	32.6	38.0				38.0	40.3
	Total Hours		50.0			49.2						57.7
Assistant Professor	Student Conference	4.0	4.2	5.0				2.0	2.0	2.0	1.0	2.3
	Official Meetings	1.0	1.3	2.0				1.0	1.0	1.0	1.0	1.0
	Executive & Official	4.0	4.3	5.0				0	0	0	0	2.0
	Research	0	2.6	6.0				28.0	30.6	34.0	8.0	10.0
	Prof. Improvement	2.0	6.0	10.0				6.0	8.0	10.0	6.0	9.3
	Teaching Hours	31.0	32.6	34.0				14.0	18.0	23.0	33.5	37.8
	Total Hours		51.0						59.6			62.4
Instructor	Student Conference	0	0.5	1.0	0	1.1	2.0	0	1.0	3.0	0	1.0
	Official Meetings	0	0.5	2.0	0.3	1.1	2.0	0	0	0	1.0	1.0
	Executive & Official	0	4.0	10.0	0	1.4	3.0	0	0.6	2.0	0	1.0
	Research	0	1.0	2.0	0	6.0	6.0	1.0	11.3	17.0	4.0	6.0
	Prof. Improvement	3.0	8.1	15.0	6.0	9.9	15.0	0	0	0	10.0	12.5
	Teaching Hours	18.0	25.0	42.5	28.0	29.1	35.0	23.0	25.6	27.0	44.0	45.5
	Total Hours		39.1			48.6			38.5			67.0
Assistant	Student Conference	0	0.4	1.0							0	0
	Official Meetings	0	2.0	4.0							1.0	1.0
	Executive & Official	0	0	0							2.0	3.5
	Research	0	23.1	39.0							34.0	38.0
	Prof. Improvement	0	18.6	38.0							13.0	13.5
	Teaching Hours	0	16.3	23.0							0	0
	Total Hours		60.4									56.0

PLATE I. Division of Time, in Hours per Week, Spent on College Service

NOTE: Center figures are the average number of hours per week for the t
ures at the left are the least and those at the right, the largest number of hours

	Chemical Engineering			Civil Engineering			Electrical Engineering			Industrial Arts	Mechanical Engineering			Engineering	Engineering Ec. Science
	4.0	7.0	13.0	4.5	7.6	10.0	10.0	10.6	12.0	7.2	6.0	10.0	12.0		
	1.0	1.0	1.0	2.5	3.1	4.0	2.0	3.3	4.0	2.5	3.0	5.0	6.0		
	9.0	11.6	14.0	16.0	16.6	18.0	20.0	20.0	20.0	10.0	18.0	19.0	21.0		
	4.0	5.6	8.0	2.0	3.0	4.0	0	0	0	0	0	0	0		
	2.0	5.6	9.0	8.0	9.0	10.0	0	3.5	5.0	4.0	0	0	0		
	20.0	24.3	25.0	18.0	19.6	20.0	15.0	18.6	22.0	25.5	24.0	26.0	27.0		
		55.1			58.9			56.0		49.2 ©		60.0			

© Based on one quarter only.

			1.0	2.1	4.0	2.0	2.0	2.0		0	1.8	3.0	1.5	2.6	3.0	3.0	4.0	5.0
			2.0	2.7	3.5	0	0.7	1.0		1.0	1.8	3.0	1.0	1.7	2.5	2.0	3.5	5.0
			3.0	5.6	10.0	0	0	0		0	4.7	8.0	9.0	10.3	11.0	8.0	10.7	12.0
			4.0	6.3	10.0	22.0	27.0	36.0		0	0.4	2.0	0	1.0	2.0	3.0	5.7	6.0
			0	6.7	9.0	0	4.7	10.0		0	6.2	10.0	0	0.4	0.7	6.0	7.3	10.0
			23.0	33.1	43.0	7.0	16.7	22.0		13.0	33.7	44.5	27.0	30.5	34.0	23.0	27.5	30.0
				56.5			51.1				53.2			46.5			58.7	

$ Not in Ave.

* Half time - Engr. Exp. Station, 1 Man.
X " " - Dept., 1 Man

	1.0	1.3	2.0	1.0	3.6	8.5	1.0	4.0	7.0	2.0	2.8	4.0	1.0	3.2	6.0	3.0	3.5	4.0	1.0	4.2	8.0
	1.0	2.3	3.0	0	1.8	4.0	0	2.6	4.0	0	0.3	0	0.5	3.1	2.0	1.0	1.0	1.0	1.0	1.2	1.7
	5.0	5.5	6.0	0	6.3	11.5	0	7.6	15.0	0	0.3	1.0	1.0	2.6	6.0	5.0	5.3	6.0	3.0	4.0	5.0
	0	3.3	3.0	0	7.6	34.0	0	3.5	8.1	0	0	0	0	0	0	0	0	0	0	0	0
	5.0	5.0	5.0	2.0	8.6	12.0	2.0	1.6	3.0	7.0	8.0	10.0	1.0	1.7	3.0	3.0	3.4	4.2	3.0	8.0	13.0
	38.0	40.3	43.0	18.0	34.7	54.0	18.0	36.5	43.0	40.0	47.2	54.0	37.3	42.4	52.0	34.0	44.6	54.0	28.0	36.5	44.0
		57.7			62.6			55.8			58.6			53.0			57.8			53.9	

2.0	1.0	2.3	4.0	2.0	4.0	6.5	3.0	3.6	4.0	0	0	0	1.0	2.5	5.0			
1.0	1.0	1.0	1.0	0	1.1	2.0	1.0	1.6	2.0	0	0.2	1.0	0	0.5	1.0			
0	0	2.0	3.0	0	1.0	2.0	1.0	4.0	8.0	0	2.0	6.0	0	1.5	3.0			
34.0	8.0	10.0	12.0	0	2.5	10.0	0	0	0	0	0	0	0	0	0			
10.0	6.0	9.3	14.0	4.0	7.3	13.0	0	3.0	6.0	0	5.0	12.0	0	3.7	13.0			
23.0	38.8	37.8	40.0	34.0	39.7	48.0	40.0	43.1	48.0	30.0	38.8	48.0	18.8	45.6	63.0			
		62.4			55.6			55.3			46.0			53.8				

3.0	0	1.0	2.0	0	2.4	7.5	0	2.8	5.0	0	1.0	3.0	0	0	0	13.0	19.0	23.0	2.0	3.6	6.0
0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.2	4.0	0	0	0	0	.3	.3	2.0	2.5	3.0	1.0	1.0	1.0
2.0	0	1.0	2.0	0	1.5	3.0	1.0	3.1	6.0	0	0	0	0	0	0	3.0	11.0	20.0	0	1.6	5.0
17.0	4.0	6.0	8.0	0	5.5	15.0	0	1.6	9.0	0	0	0	0	0	0	0	2.0	3.0	0	0	0
0	10.0	12.5	15.0	0	10.4	18.0	0	6.7	13.0	0	0	0	0	2.2	8.0	1.0	5.3	8.0	16.0	18.0	20.0
27.0	44.0	45.9	47.0	24.0	37.7	48.0	33.0	39.2	43.0	44.0	49.0	52.0	21.0	37.1	38.0	11.0	18.8	23.0	41.0	42.0	43.0
		67.0			58.5			54.6			50.0			39.			58.6			66.2	

△ Personnel Dept. Work.
◆ Half Time

	0	0	0	0	0.3	2.0	0	1.8	6.0		0	0.2	1.0			0	0	0
	1.0	1.0	1.0	0	0.3	1.0	0	0.3	0.6		0	0.1	0.5			0	0.6	1.0
	2.0	3.5	5.0	0	0.3	3.0	0	0	0		0	0.5	1.0			0	0	0
	34.0	36.0	38.0	0	7.0	20.0	0	7.4	18.0		0	0	0			0	0	0
	13.0	15.5	16.0	4.0	20.6	35.0	0	17.3	23.0		24.0	26.1	33.0			0	14.6	33.0
	0	0	0	14.0	24.2	30.0	0	16.8	29.0		17.5	25.5	31.0			21.0	28.0	38.0
		56.0			52.7			43.6				52.4					43.2	

ollege Service by Engineering Faculty Members, College Year 1927-1928.

week for the three quarters of the year for all men in that rank. Smaller fig-
mber of hours found in any one quarter of the year for all men in that rank.

February issue of this JOURNAL, and it shows a grand average of total hours for the year of 9.285 hours per day or 51.07 hours per week of five and one-half days.

The average of all the teaching hours for each rank in the division was determined, also the average of all the total hours for each rank. The per cent of the total hours spent in teaching was also determined for each rank. These averages were plotted and may be found on Plate II. This plate shows very strikingly the fact that the Associate Professor, Assistant Professor, and Instructor carry not only a greater number of hours of teaching work but their teaching load is also a greater per cent of their total load than in the case of the other ranks in the division. We find in the report for Michigan State College as above referred to that the average teaching load of the E. E. department there was 44.2 per cent of the total time. Our average for this is 55.3 per cent. The hours per week spent in student conference, official meetings and executive and official work is the highest for the Professor in charge. This is as would be expected. For research and professional improvement we find the Assistants highest which also might be expected since many of these are working toward a Master degree.

Professional Improvement.—Professional improvement is to some extent rather intangible and difficult to specify. It was defined in this survey, however, as: Technical reading or study not required for immediate class use; preparation or reading of papers for technical meetings; graduate study; consulting practice of a broadening nature; etc.

A wide variation in this item may be noted, and it was therefore analyzed to determine its effect on the total number of hours reported by the various departments. Plate III shows the result of this analysis. First the total hours for all men in each department were averaged and the departments were arranged in the order of these average total hours, and these total hours were plotted against departments. This line shows the relative position of the various departments as regards total load. In the same manner the total hours without Professional Improvement were determined and plotted above

the various departments. The vertical distance between these two lines represents the hours in Professional Improvement, and it is easy to note from this the relative position of the departments in this regard. It may be noted that the dif-

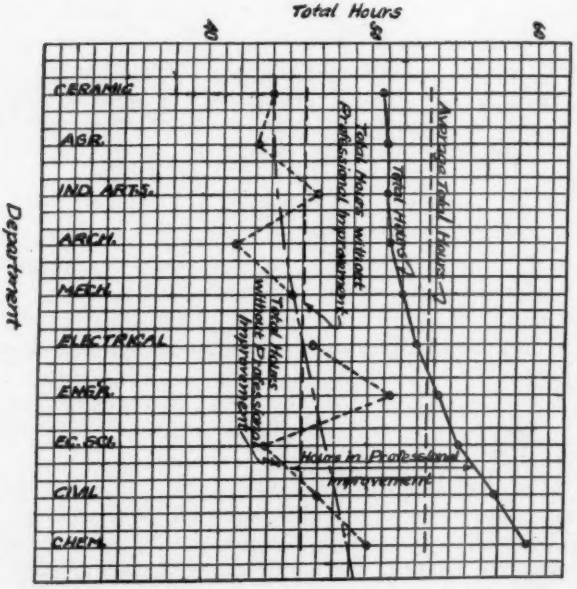

PLATE III. Study of Total Hours of Teaching Staff of Engineering Faculty, Iowa State College.

ference between the two average lines is seven and six-tenths hours per week. The larger number of hours for Professional Improvement as reported by Engineering Economic Science, Civil Engineering and Chemical Engineering throw the dot and dash line farther away from the line of total hours than for the other departments. Plate II also shows this difference arranged according to rank of the men. It also shows the teaching load in per cent of the total load not considering Professional Improvement. The only noticeable ef-

fect of this item is to lower the total hours and raise the per cent of time in teaching. It does not disturb the relative positions of the various ranks. It does show a larger number of Professional Improvement hours in the case of the Graduate Assistant as would be expected.

Means of Computing an Instructor's Load

It must be realized at the outset that an instructor's load depends on a number of factors and it is difficult to express this load in terms of these factors. The load depends on the types of courses he is teaching, it depends upon the number of sections in each course, and it depends upon the number of students he is teaching in each course.

Type of Course.—It was soon noticed that there was a wide difference in the amount of work necessary to teach various courses. After studying the case carefully it was decided to group all courses into one of six groups as follows: Recitation Courses; Recitation and Lecture Courses; Recitation, Lecture and Laboratory Courses; Manipulative Laboratory Courses; Design Laboratory Courses; and Testing Laboratory Courses. These groups vary as to the amount of preparation, class time, or grading work. All courses were grouped under one of the above after conferring with various instructors in the various lines of work and after careful consideration by the Committee. In some cases classification was very difficult and the choice of the Committee in these cases may be a fit subject for argument.

The teaching load for any course is made up of three distinct divisions. First, there is the preparation necessary before the instructor meets the class. Usually this preparation is independent of the number of sections taught in each course and the number of students in the sections. Two sections in one course would take no more preparation than would one section. There may be a few exceptions to this but the Committee decided to ignore these exceptions. Second, the instructor spends a specified number of clock hours per week in the classroom or laboratory and this may be determined from the credit hours in the course. These hours

vary with the number of sections taught but are independent of the number of students. Third, a rather definite amount of time is required in each course for marking papers. This is independent of the number of sections but is directly dependent on the number of students taught.

A formula giving the teaching load for any course may therefore be written as follows:

$$T = H + PC + GS,$$

where T = total teaching load in clock hours per week in any course,

H = total classified clock hours per week in the course,

C = credit hours per week for one section of the course,

P = preparation constant = $\dfrac{\text{Hours preparation}}{\text{Cedit hours (1 section)}}$,

G = grading constant = $\dfrac{\text{Hours spent in grading}}{\text{Number of students}}$,

S = number of students in course.

C is to be taken from the catalog, H from the instructor's class schedule, S from the class roll, P and G from Table 2 and Table 3 of this article.

TABLE II

PREPARATION CONSTANT = P

	Fall 1927	Winter 1928	Spring 1928	Average
Recitation	1.0	1.0	1.3	1.1
Recitation-Lect.	1.0	0.8	1.6	1.1
Recitation-Lect.-Lab.	0.6	0.7	0.8	0.7
Manipulative Lab.	0.9	0.5	0.7	0.7
Design Lab.	0.9	0.8	1.7*	1.1
Testing Lab.	1.2	1.6	1.1	1.3

* High value caused by engineering problems.

TABLE III

GRADING CONSTANT = G

	Fall 1927	Winter 1928	Spring 1928	Average
Recitation	0.10	0.12	0.12	0.11
Recitation-Lect.	0.06	0.05	0.09	0.07
Recitation-Lect.-Lab.	0.13	0.11	0.17	0.14
Manipulative Lab.	0.09	0.08	0.11	0.09
Design Lab.	0.08	0.08	0.12	0.09
Testing Lab.	0.15	0.16	0.17	0.16

P was determined by taking the hours spent in preparation as reported for each course and dividing by the credit hours for that course. These values were then averaged for each type of course.

The following example will illustrate the use of the above formula: Assume an instructor teaching two sections of M. E. 312 (Mechanics, Strength of Materials) with 20 students in one section and 15 students in the other section, or 35 students total.

M. E. 312 carried 5 credit hours, and is classified as a recitation course. Under this classification we find in tables 2 and 3, $P = 1.1$ and $G = .11$.

Formula is:

$$T = H + PC + GS.$$

$$\therefore \text{ Teaching load } = 5 \times 2 + 1.1 \times 5 + .11 \times 35$$
$$= 19.35 \text{ clock hours per week.}$$

This formula has been applied to several classes taught by members of the committee and to other members of the engineering faculty, and the results check reasonably close with actual hours spent. At Iowa State College one laboratory credit hour is three clock hours.

It must be remembered that the above tabulation curves and formula represent averages of the entire division, and in some cases the values used to determine the averages cover

a rather wide variation. On the whole, however, there was reasonable uniformity and the averages are therefore reasonable.

QUESTIONNAIRE

On time spent on College Work. Actual Clock hours per week.
Name..... Rank..... Dept..... Date.....

Character of work

List subjects taught in spaces at top of columns. Under each course put number of actual clock hours per week required for the various items listed on the side of the sheet. Work which does not come under any course, list under General. At bottom list names of faculties and committees of which you are a member.

Course Numbers									
Preparation									
Teaching									
Correcting written work									
Number of sections									
Total number students in course									
Is text book new to you this quarter?									
Have you taught course before?									
Assisting or in charge?									
Student conferences									
Official meetings									
Executive and office									
Research									
Professional improvement									
Total hours									

Faculties and Committees.....

Please indicate on back what line work or study you have included under "Professional Improvement."

REPORT OF THE CONFERENCE ON ORIENTATION AND ENGINEERING PROBLEMS COURSES

June 20, 1929, at Annual Meeting of the Society, Ohio State University

The committee held a conference on Thursday, June 20, 1929, at the Columbus meeting of the S. P. E. E. The topic for discussion was "The Organization and Administration of Engineering Problems Courses." Talks were given by several members and the chairman read letters from two who were unable to attend the meetings. A collection of student papers and course outlines was placed on exhibition. The conference was well attended and considerable interest was manifested in both the discussion and the exhibit of materials.

It was suggested at the meeting held at Orono, Maine, that there seemed to be four principal types of direction for Engineering Problems courses and also various groupings of subject matter. The committee decided that descriptions of these courses might be of interest and so the Columbus conference was arranged. Representatives from several schools were asked to give talks presenting the the essential information regarding their Engineering Problems courses. The various types of control and the speakers describing the courses were as follows:

1. Committee control of a training course coordinating engineering and physics. Dean H. S. Rogers, Oregon Agricultural College.
2. Departmental direction of specialized course, largely laboratory and informational, with some problem solving. Professor C. E. Bullinger, Pennsylvania State College.
3. Independent department directing of training course coordinating physics, mechanics and drawing. Professor E. R. Wilcox, University of Washington.
4. General Engineering Department under the Dean of Engineering. One man in charge of training courses coordinating mathematics, physics and engineering. Professor F. C. Dana, Iowa State College.

Reports were also read from the following: Professor S. W. Dudley of Yale; Professor J. J. Richey of Texas A. & M. College.

Following the discussion of the reports the meeting adjourned to another room where the student papers had been arranged for inspection.

Since some members who were unable to attend the conference may also be interested in the details of the talks, the committee includes the available papers as an appendix to this report.

Respectfully submitted,

Committee on Orientation and Engineering Problems Courses,

C. W. BEESE,
J. J. RICHEY,
E. R. WILCOX,
E. H. WRIGHT,
F. C. DANA, *Chairman.*

ENGINEERING PROBLEMS AT OREGON STATE COLLEGE

The engineering problems courses at Oregon State College have been organized and developed for certain specific and general objectives among which the four principal ones are, first, the orientation of the student with respect to the field of engineering; second, the development of appreciation of the close relationship between the various units of all engineering curricula; third, the mastery of some few fundamental principles and an appreciation of the manner in which these are applied in the fields of civil, mechanical, and electrical engineering; and, fourth, training and discipline in engineering habits, interests, and ideals. The organization of course syllabi, the allocation of time and credits and the form of organization for administering the work have all been developed for the specific purpose of accomplishing these objectives.

The engineering problems courses are a unit of one of the sequence of courses extending throughout a curriculum common to all freshman engineering in the school. In this common curriculum are four major channels of training, one, a group of general engineering science and technology in which students take two credits of engineering problems and two credits of mechanical drawing each term; two, a group of mathematical and physical science in which students take five credits of mathematics and three credits of physics each term; Three, a sequence of English Courses in which students are trained in English composition throughout the entire year; and four, a sequence of military and physical education.

In the problems courses students meet three times a week, once for a general lecture lasting throughout a period of 50 minutes, and twice for computation periods of two hours duration each. The entire freshman engineering group is assembled for the lectures but is divided into sections of from sixteen to twenty-four members for the computing work. For this work the students receive two credits each term which is about one-ninth of the entire term's work.

The syllabi of these courses were organized upon the principle that civil, mechanical, and electrical engineering are in a large part respectively fields of application for the mechanics, heat, and electricity of physics. The sequence of training has, therefore, been made parallel with that of the course in physics. In the first term when students are studying the mechanics of physics, the engineering problems course is drawing its descriptive problems from the field of civil engineering and the lectures are used for broadly describing these fields. In the second term when the subject of heat is being studied in physics, mechanical engineering is presented in the problems course, and in the third term, when electricity is studied in physics, electrical engineering is studied in problems.

In order to make this correlation most effective and to also correlate the work of mathematics with other freshman sequences a joint syllabus for the entire three years was prepared by a committee of the mathematics and physics depart-

ments which are outside of the engineering school and the committee on freshman instruction which is within the engineering school. This syllabus was drawn in very complete form and outlined the work of each week of the term and the correlation between engineering problems and physics has been achieved to a very gratifying extent although it has been somewhat more difficult to immediately relate the entire work in mathematics with the differentiated fields of subject matter in the problem courses.

In the first part of the civil engineering problems work, students are trained in the theory and use of the slide rule and are rapidly introduced to mensuration through surveyed areas and volumes of earth work. In the meantime the physics department is introducing the fundamental concepts and developing an appreciation of composition and resolution of forces, of parallel forces, and couples, and of non-concurrent forces. Lagging two weeks behind the work in physics, civil engineering work takes up the graphical analysis of forces as applied to very simple problems with the emphasis upon the methods of work and the manner in which engineering principles are applied to the solution of tangible projects. This correlation and sequence is kept in a very satisfactory manner throughout the entire year's work and a broad appreciation of the engineering principles of physics as tools in the engineering field is, thereby, developed concurrently with a specific understanding of their application in an engineering manner.

The lectures paralleling this problem work are of multiform nature. The introductory one, given by the dean of the school, is upon the topic "What Is Engineering," the second one is a general description of the field of civil engineering, the third and fourth take up the problems of surveying and highway and railroad engineering at a time when the students are solving problems in areas and earthwork volumes and are making estimates upon relatively simple work. The next one takes up structural engineering as a sub-division of civil when the students are studying forces in physics and are solving simple engineering problems in the computation

periods. Another takes up water power and hydraulics when the students are studying the principles of work and the laws of falling bodies. So, throughout the entire year it is possible to obtain a remarkably close correlation between these generally descriptive lectures which are many times given with illustration by means of lantern slides and moving pictures, the engineering problems of the computation period, and the training in principles given in physics.

In order to provide for the differentiated points of view required in the problems courses, the staff was organized with representatives from the civil, mechanical, and electrical engineering departments and the courses in problems and engineering drawing were organized as a group of courses in general engineering.

In order to weld the freshman instructors into a unit, they were organized as a committee with one of their number, an assistant professor in the department of civil engineering, as chairman of the committee. This committee is responsible for both engineering problems and drawing. The vice-chairman of the committee is immediately responsible for the drawing work and is an instructor in the department of mechanical engineering. The responsibility for the selection, organization, and development of work in civil, mechanical, and electrical engineering is laid upon the representatives from the respective fields. But all of the instructors participate in the instruction each term. For example, in the first term, instructors from all three departments teach civil engineering, in the second term, mechanical, and in the third term, electrical, regardless of their specific fields of training or the department in which they are employed.

Through this organization it was felt that a better balance in the three divisions could be maintained than through an organization in which all instructors were in one department. To give a continuing vitality to the work each of the instructors so employed is assigned work in his major department of such a nature as to keep his professional contacts and ambitions alive. The general committee is responsible directly to the dean of engineering but all department heads have co-

operated in a most effective manner in the development of the work.

This common freshman year is a unit of training in the various curricula of civil, mechanical, and electrical engineering which have been developed upon a common pattern of organization. Beginning with the sophomore year each major curriculum takes up its thread of particular training in the channel assigned distinctively to it. The civil engineering curriculum takes up mechanics, the mechanical engineering takes up elementary heat, and the electrical engineering takes up introduction to electrical engineering. In the sophomore year the civil engineers begin their field work and the mechanicals and electricals begin their shop work. In the third year each curriculum emphasizes and expands the major basic and fundamental principles distinctive to it, such as structural analysis and hydraulics, thermo-dynamics, and principles of electrical engineering. In the fourth year the fields of application are studied more broadly. Concurrently with these differentiated sequences of engineering science and technology, the band of mathematical and physical science is continued until the first term of the junior year and the group in English, economics, and social sciences is extended throughout the entire four years.

The orientation of the student in engineering is accomplished by the lectures which are given by men from all departments at the request of the freshman committee and by visits to the engineering shops and laboratories at certain appropriate times in the period of training. During the entire year, the students may be addressed by seventeen or eighteen different professors from the school. They will, thereby, have an opportunity to become acquainted with the leaders in the various departments. An understanding of engineering habits and methods is developed in the computation periods. The appreciation of the close relationship between the units of engineering curricula is developed by the coordination of the entire freshman training itself and by various impromptu discussions in the computing periods upon this particular topic. The understanding of a few fundamental principles of civil,

mechanical, and electrical engineering is considered more or less as a by-product of the course. Their mastery is emphasized more particularly because of the demonstration of the common nature of engineering thinking and working than because of the principles themselves.

In the introduction of work in the computing periods the inductive method is used as far as practicable. Students are coached in the development of effective habits of initiative, concentration, and diligence. Emphasis is placed upon accuracy, thoroughness, orderliness, and neatness as engineering traits, standards of sketching and problems of composition are constantly stressed and the students respond to these in a very gratifying manner. It is very interesting, for example, to compare the problem work of the first week with that of the last.

The engineering faculty is unanimously agreed that there are very substantial evidences of this early training in all subsequent courses. This early introduction to things more typically engineering is also a means of eliminating those with mechanical interests of a trade level from a course in training which requires capacities and interests in abstract thinking and analysis. Paralleling this instruction, our personnel work has been developed as an integral part of our instructors' responsibilities and all instructors are taking a very live interest in the development and progress of engineering students.

As time goes on we make minor changes in organization, in content and in methods of presentation, but the general objectives, purposes and ideals, we believe, are fundamentally sound and we expect to adhere to them.

PENNSYLVANIA STATE COLLEGE

All the Engineering Problems courses are given by the individual departments and, therefore, are specialized subjects. The courses are offered in the following departments: civil, electrical, industrial and mechanical engineering. All are under the direction of the various departments heads and are

taught by the men of that particular staff without reference to other subjects.

The essential facts regarding the various departmental courses are as follows:

Civil Engineering.—Two semesters work having one three-hour period per week are given in the freshman year. The subject matter consists of a series of problems designed to acquaint the student with some of the work of the civil engineer. The problems utilize principles from mechanics, physics and mathematics.

Electrical Engineering.—Students in this department take two terms' work in Engineering Problems, one in the first semester of the freshman year and second in the second semester of the sophomore year, each having a single three-hour meeting each week. This is essentially a laboratory course intended to introduce the student to the construction, operation and application of the more common types of electrical apparatus.

Industrial Engineering.—A course is given in both semesters of the freshman year each meeting once a week for a three-hour period. The material used consists of a series of problems designed to acquaint the student with some of the work of the industrial engineer as a preparation to taking up the theory of industrial organizations.

Mechanical Engineering.—A course having one three-hour period per week is given during the first semester of the freshman year. Students are given a point of contact with their mechanical engineering subjects and are assisted in becoming familiar with the machines and apparatus commonly used in the laboratory.

UNIVERSITY OF WASHINGTON

The foundation work upon which was built up the courses in engineering problems at the University of Washington began in 1915 when Professor C. C. More organized a class in freshman mechanics for architects. The following year he started an experimental class in freshman machanics

for engineering students. In the fall of 1917 the college of engineering required of all engineering freshmen a course in engineering problems which in the absence of Professor More was organized by Professor W. E. Duckering. The courses were continued under the civil engineering department, using the project method supplemented with much drill work, until the fall of 1924.

At this time, through the efforts of Dean Magnusson, a new department was formed in the college, called the department of general engineering. To this department were given all the first year engineering courses, these being engineering drawing, engineering problems and the elementary surveying course. With this separate administrative organization a freshman personnel service was instituted. The teaching staff of the department was made up mainly of instructors who had been teaching the freshman courses under the civil engineering department.

At present the staff is composed of two associate professors, six assistant professor and eight instructors, not all of whom are giving full time to the freshman work. These instructors also teach classes in mechanics, hydraulics, structures or other upper class subjects. Each teacher is responsible to the department for the courses which he teaches in that department. This method of cooperation between departments has worked out satisfactorily.

The courses in problems, engineering drawing and surveying are all closely correlated, as to methods of instruction, training and standards by means of outlines and frequent conferences. The course in engineering problems runs throughout the year, simple applied mechanics being the subject matter for the first two quarters, and applied descriptive geometry for the third quarter following two quarters of drawing. The courses are taught in three two-hour sessions per week with approximately three hours' work outside of class required. No single textbook is used for the course but the students are referred to elementary mechanics texts and to descriptive geometry books to help clear up their difficulties. Much material is furnished the student in the form of mimeo-

graphed notes, for which the student pays a small laboratory fee. In the oral class work the instructor develops the topics by group discussion, the members furnishing most of the information and ideas from which general working principles are evolved. These principles are discussed and clarified as the students feel the need for them in the solution of some problem which has been presented to them. The latter half of each session is usually used as a computation and problem solving period. Classes are limited to twenty-five.

The broad objectives of engineering problems courses are to begin the presentation and to promote the practice of the "engineering method," that is, the application of scientific truths and mathematical manipulation to the solution of specific and practical problems dealing with "materials, money and men." The ability to get correct and usable results is a major consideration in all engineering. A further objective is to assist the first year student to a proper placement in or out of the engineering courses.

These objectives are approached by three paths:

A. *Training.*—The establishment of efficient habits of work and methods of study. (If one of these three paths may be called the main road, this is it.)

B. *Instruction.*—The presentation of subject matter. (Elementary mechanics and descriptive geometry because of their basic relationship to all engineering have been found to be a very satisfactory subject material.)

C. *Vocational Guidance.*—Assistance in getting the student started in the kind of work to which he can best adjust the sum total of his characteristics. This brings happiness and efficiency.

A. Training

Aims	*Methods*
1. To help the student acquire the engineer's viewpoint in attacking a problem.	By taking problems from practical engineering settings and coaching the student in methods of analysis and solution.
2. To help him to acquire proper habits of work, in order to	By pointing out personal deficiencies and holding to a few

attain more speedy and dependable results and to have his computations and methods "unmistakably clear."	well-chosen clearness regulations, proper notebooks, etc. Negative grades are given for lack of clearness.
3. To help him acquire proper habits of study and make efficient use of his time.	By calling his attention to poor procedure and suggesting better, and by having him read books on "How to Study" and write a paper on how he has applied any new ideas gained from this reading.
4. To develop his initiative.	By keeping him confronted with new difficulties and new situations which may be satisfactorily met by applying basic principles with which he is already familiar.
5. To impress upon him the importance of accuracy.	By grading largely on results and by constant warning of the disastrous effects of errors in engineering calculations.
6. To train him to check his work whenever possible, in order to develop self-confidence.	By requiring him to check every problem possible.
7. To bring him to a realization of the value to an engineer of good English, both spoken and written.	By occasional papers on engineering subjects which are carefully graded by the engineering English instructor and by careful attention to spoken English in class.
8. To accustom him to a certain amount of discipline so he can learn to adjust himself to an organization and to cooperate with others.	By certain discipline in class and insistence upon following directions.
9. To stimulate in him a keen interest in engineering and thereby to make him happy in his work.	By constantly using outside contacts and experience for amplifying the problem he is working on.

B. Subject Matter

Aims	*Methods*
To instruct in the understanding of the ability to use the simple situations;	The principles of physics and mathematics and drawing which appear in the opposite column and which the student is eventually expected to understand and be able to use are very largely those with which he is supposed to have some familiarity from his high school preparation. He is lead to rediscover these for himself in so far as is possible out of his own past experience. He finds that these simple principles may be used in an endless variety of situations. He is encouraged to master these principles so thoroughly that he will have confidence in his ability to use them in situations that are new to him.
1. Methods of computation. Use of graphical and mathematical tools such as arithmetic, algebra, geometry, slide rule, etc.	
2. Concepts of Force, Energy Work and Power, with especial emphasis on the Conservation of Energy.	
3. Newton's three laws.	
4. Equilibrium Laws, and Free-body sketch.	
5. Rates, such as acceleration, velocity and distance relationships.	
6. Vector analysis in algebraic and graphical solution of stresses in simple structures.	
7. Load, shear and moment in simple beams.	
8. Elementary principles of hydrostatics.	
9. Elasticity of Materials, especially Hooke's law as applied to simple design.	
10. Principles of descriptive geometry.	
	Classes are sectioned on the basis of ability to grasp and use these principles. Methods of instruction are varied to fit the different sections.
	These same subjects are reviewed and built upon in the sophomore and junior mechanics courses, thus making use of the principle of relearning.

C. VOCATIONAL GUIDANCE

Aims	*Methods*
1. To help the student to discover the nature and extent of engineering work.	By encouraging him to read biographies, technical magazines, etc.
2. To help the student to discover whether or not he is a good prospective engineer.	By giving placement tests in mathematics, physics and drawing, by showing him the need of certain qualities and abilities, and getting him rated on these items by several different instructors.
3. To help him to decide what branch of engineering he wishes to enter.	By talks from members of the faculty of each department. By requiring him to read some specified books. By having him write a paper on the job he expects to take upon graduation. By personal contact with other students and faculty members.

The foregoing brief of the aims and methods of our engineering problems courses show, what we are "shooting at." It might be better for an unprejudiced observer to plot a scatter diagram to show how close we are coming to the bull's-eye which is the most effective and efficient procedure possible for selecting and beginning the training of the would-be engineer. However, we shall risk being called prejudiced and unscientific and note a few results which we think we are achieving. In the first place we note that we are gaining and holding the student's interest much better than before, when he had no engineering contacts the first year. Now we all know that interest is the very center and hub of the learning process. In the second place the student sees and feels in the problems work an actual and immediate need for the mathematics and science which he is compelled to take. Without this felt need it is sometimes hard for him to accept on faith the situation that we must know these subjects in order to understand his advanced work.

Furthermore the opportunity to make effective contact with engineers and get their point of view immediately upon entering college saves false starts for some and increases the determination of others to go on. These contacts also give the student, if the problems courses are well handled, an opportunity to gain some idea of the social and economic aspects of the profession which influence to a marked degree what he gets from his following courses.

The type of training which the student receives in the problems courses does accelerate the learning process and increases his personal efficiency as is shown by the average general improvement in the student's work in his sophomore and junior subjects. This is especially shown in his increased understanding of and respect for orderly thinking and intelligible form in recording the results of his efforts. This training is particularly noticeable in comparing the upper class work of our own students with those who have transferred from other schools where such freshman work is not given. All in all we are convinced that the advantages accruing from the introduction of a freshman engineering problems course far outweigh whatever disadvantages may accompany the necessary changes that may have to be made.

IOWA STATE COLLEGE

The Engineering Problems courses were introduced at Iowa State College in the fall of 1919 by Professor William E. Duckering. The courses are offered in a department of General Engineering of which the Dean of Engineering is the head. Various "service" courses are given in this department, each having one man in actual charge. The Engineering Problems courses are directed by the writer assisted by one full-time man. Since two men can handle only half the sections, it is necessary to borrow the rest of the teaching staff from other departments. Four men are usually obtained from mathematics and physics, and four to eight more from engineering departments.

When first organized the courses were planned to utilize

certain mechanics principles as the vehicles for the desired training, but the original plan was gradually revised, beginning about 1922, and the subject matter of Engineering Problems changed so as to coordinate more closely with mathematics instead of mechanics. Various members of the engineering faculty felt that added emphasis could thus be given to some of the courses in mathematics without losing the valuable training features of the original plan. Five courses are offered, two are required during the freshmen year, one during the sophomore year and two are elective. All classes meet for one three-hour period per week. The content of each course is as follows:

Freshman Year, First Quarter.—The practical applications of algebra to problems dealing with forces, work and power. Training in engineering analysis. Instruction in the use of the slide rule. Training in making clear, systematic computation sheets.

Freshman Year, Second Quarter.—Applications of trigonometry to various engineering problems. Further instruction in the use of the slide rule. Added emphasis on the use of specifications and standards in obtaining workmanlike computation sheets.

Sophomore Year, Third Quarter.—Practical problems based upon the engineering applications of calculus. Cooperating with the mathematics, parts of physics and the first course in mechanics. Use of tabulations and other office methods of reducing labor in computations.

First Elective Course.—This is open to all students except freshmen but it is intended primarily for students coming to us with advanced standing. The course gives them the necessary training in our systems and standards and in the use of the slide rule so they can go ahead on an even footing with the students who entered here as freshmen. The subject matter concerns simple quantity surveying and pricing of materials.

Second Elective Course.—This course is likewise open to all except freshmen. It is now a one credit course, but will be raised to two credits next year. The subject matter deals

with some of the applications of graphic logarithms. Advanced slide rule instruction is given, uses of various logarithmic coordinate papers and the construction of simple nomographic charts.

"Study Problems" are generally used to introduce new principles in these courses. The problems are actual or possible situations in an engineering setting and the solution requires the use of the principle which the instructor wishes the student to learn. Since reasoning does not occur in the absence of a difficulty, that is, a "problem," the situation is discussed until the class clearly perceives that a real problem exists. They are then led to state the problem in definite form, so that the group sees the objectives of their efforts. Now, by adroit questions, comments and apt illustrations, by suppressing his own knowledge and apparently accepting all suggestions from students; by avoiding direct statements of his own opinion, but encouraging students to criticize their ideas; the instructor gradually leads them to the point where the basic principle is clearly stated. The discussion must necessarily be guided and controlled by the instructor or chaos results and the time is utterly wasted. It is obvious that this type of instruction calls for a thorough knowledge of the subject on the part of the instructor and for a keen, flexible mind which sees each usable opening in the discussion. The most successful instructors enjoys this inter-play of minds and the challenge to his ingenuity. He must be mentally alert for no two classes will react in the same manner. The teacher who asks a stereotyped set of questions as in a formal quiz, then literally "lays down the law," is a useless misfit in this type of instruction. It is a commonplace saying that the only true education is self-education and, therefore, the instructor should be merely a guide, simply endeavoring to induce the pupil to think for himself. Since thinking is distasteful to the majority of men, they will willingly do it only when their interest is aroused, and hence, the problems chosen should be live, practical situations of obvious value. Whenever possible the settings and data for the study problems should be drawn from members of the class. The interest is

much keener and students feel that they are sharing in the experiences of engineers.

After the basic principles have been brought out in the discussion of the study problem and they have been successfully applied to a numerical solution, the student is given the opportunity to test his ability to apply the principles to a new problem. We usually refer to them as "Drill Problems." Although they involve the same principles as the study problem, the settings are changed so as to prevent the obtaining of answers by imitative methods. The pupil is thus encouraged to think for himself and eventually reason his way to a solution.

The drill problems are to be solved in a logical manner and recorded in neat form on a special paper that has been adopted as a standard by the engineering division. The work must be prepared in accordance with a set of specifications which has been found to be very satisfactory both in the classroom and the engineering office. Mussy, ill-arranged sheets receive little or no credit and the student who works for answers only, soon finds his grades dropping because of his slovenly work.

At Iowa State College all work is done in the classroom. No outside assignments are given and credit is given only for work done under the instructor's supervision. Desks are assigned and men are not allowed to wander about the room. Talking, team work on a problem, comparing of results, etc., are not permitted. Students are expected to have their own material and borrowing is discouraged. Thus the leaners are forced to do their own thinking and be responsible for their own equipment. Problem sheets are each man's individual work and thus a reasonably accurate measure of his achievement is obtained each period.

Instructors in other departments report that there is a startling difference in the quality of the work done by students who have had this training and that done by men who have come to us from other schools where no Engineering Problems courses are given. Not only is there a distinct improvement in the written work, but the men also seem to know

how to go at a new problem and to accept difficult tasks without grumbling. While taking the Engineering Problems courses, students sometimes feel that our standards are too high, but later on they frequently admit that the training was what they needed and that they have benefited in many other courses. We feel, therefore, that Engineering Problems is decidedly worth while and gives a training seldom given in other courses.

YALE UNIVERSITY

Course I. E. 10—Sophomore Engineering

Given to all students in the Sophomore Engineering Science Group, and about one half of the Industrial Engineering Group. Students in the Engineering Science Group go forward into the Civil, Electrical or Mechanical Engineering Departments after Sophomore Year.

Term I

Lecture, one hour, general survey of the fields of engineering, about one half by professor in the Departments of Engineering, and the remainder by lecturers from outside the School. Computation periods, 2 hours per week, content as explained below.

Term II

Computation periods, 3 hours per week, content as explained below.

Administration of Courses

The course is jointly under the general auspices of the Civil, Electrical, Industrial and Mechanical Engineering Departments. The actual directing head is Professor S. W. Dudley, Chairman of the Department of Mechanical Engineering.

Teachers in other departments are assigned to teach the courses, but also carry work in their own fields. The rank of these instructors varies from instructor to associate instructor.

Subject Matter of the Course, Term I

(A) *Engineering Computation.*

Chapter 1. Accuracy, system, arrangement, clearness, approximations, checking.
Chapter 2. Construction and use of
(*a*) The Graphic Log Table,
(*b*) The Slide Rule.
Chapter 3. Engineering Problem.
Chapter 4. Graphical representations and solutions; use of cross section paper.

(B) *Engineering Observations.*

Chapter 5. Mechanical Engineering Laboratory.
Chapter 6. Electrical Engineering Laboratory.

Term II

Project No. 1. The development of a site for a warehouse.
Project No. 2. The estimate of a mine shaft equipment.
Project No. 3. The design of a hotel cold storage and ice plant.
Project No. 4. The estimate of a hydroelectric system for farm lighting.

The aims of the course are distinctly different from the course in fundamental theory relating to the same general subjects. It is offered in response to an urgent demand for some flavor of typical engineering work illustrating the use and application of the mathematics and fundamental science subjects studied during Freshman and Sophomore years. No theoretical treatment of any of the subjects considered is attempted. The course starts with the assumption that the mathematics, the physics and the analytical mechanics courses which the student has taken, or is taking, provide the necessary fundamental principles and methods for attacking a considerable range of simple engineering projects involving the correlation of the students' general experience with their training in these particular branches. The need for this correlation early in the student's career is evident to all

teachers of advanced engineering courses. Emphasis is placed upon the method of reasoning about the problem as a practical matter requiring correspondence, analysis, computation, the drawing of conclusions and the presentation of the essential facts by tabulations, curves diagrams, etc., including a brief letter of report summarizing the whole. The course attempts to put into practice the idea of "learning by doing" and brings the student face to face with the fact that in many of the most simple and elementary applications he may be wholly at a loss to go ahead independently in the application of theories and principles which in the abstract he can repeat or use on specific examples with considerable confidence.

Judging from the attitude of the students and the work which is produced from year to year, it is the opinion of the instructing staff that this course fills a very real need. It gives the students an opportunity to find out what they can do, and what they cannot do. It opens their eyes to the difference between learning a principle or a theory as an abstract statement or the use of a formula in obtaining an answer by the substitution of specific quantities given in an example carefully stated and the quite different situation which confronts the engineer when he facts a practical condition for which he must formulate his own problem, discover and analyze the conditions and factors involved, select those that are significant for the particular case in hand, assemble the fundamental principles applying thereto, proceed with the application of these principles to the work, arrive at a solution which is significant and then assemble the information and the results in an adequate form for the use for which it is intended. We believe that we see distinct influences of this sort of training on the work of Junior and Senior Year.

TEXAS A. & M. COLLEGE

The course, Engineering Problems, as given at present at Texas A. & M. College, has been in operation for one year only. It is taken by all engineering freshmen, and runs throughout both terms or semesters.

The total enrollment last September was about 700; at the end of the term only a trifle over half of this number passed the course. A little over 16 per cent of the total dropped the course early and received no grade; over 31 per cent of the total received grades of D or E, below passing, leaving only a little over 52 per cent as the number who completed the course successfully.

In the second term the total number taking second term work was 370, almost exactly the same as the number who passed the first term's work. In addition there was an enrollment of 60 students in first term work, including a few new students as well as some who failed the first term.

On account of the very heavy addition to the teaching load of the school of enginneering caused by the addition of this course, the plan adopted for administering the course was one chosen so as to keep down the teaching load as much as possible, rather than one which was thought at first to be the most satisfactory. The freshman group was taught in "sections" of 25 to 35 students, as in other subjects or courses. Groups of three or four sections met for a one-hour lecture each week, given by Professor C. W. Crawford, head of the mechanical engineering department, who was in charge of the instruction in this course. The various sections met at some other time in the week for a two-hour class period with an instructor who supervised the class work.

The course may be said to have been in effect in an independent department, being known merely as Engineering Problems 1 or 2. It is probable that in the future it will be listed as a course in mechanical engineering.

With the exception of one-full time instructor in Engineering Problems, the teachers for this work were "borrowed" from the civil, mechanical, and electrical engineering departments. These teachers were assigned to the work by the heads of the several departments and varied in rank from instructors to full professors. There were seven teachers "Borrowed" in the first term, which, added to the full time instructor and the professor in charge, made a total of nine teachers.

The subject matter of the course in the first term was chiefly trigonometry, including logarithms and instruction in the theory and use of the slide rule.

In the second term elementary mechanics formed the basis for the work done. The students were taught the fundamentals of work, power, resolution of forces, moments of forces, equilibrium of forces, acceleration, and velocity.

The principal aims of the course were as follows:

1. To acquaint the student with the nature of engineering computations.
2. To train him in clear, systematic and accurate presentation of solutions of problems.
3. To give facility in the use of tables, and of the slide rule especially, in order to make for more efficient work in succeeding courses.
4. To develop early a clear conception of the various engineering quantities and the units of measurement.
5. To develop the students' self reliance and initiative.

It is believed that the success obtained in accomplishing the desired results was quite noticeable in the case of the first four items or aims listed, but less marked in the case of the last one mentioned.

CURRICULUM CONSTRUCTION APPLIED TO A PROGRESSIVE COURSE IN ELECTRICAL ENGINEERING

JOHN D. BALL, *Vice-President and Director, School of Engineering of Milwaukee*

Numerous studies of great value have been conducted from time to time by various writers, educators, professional practitioners and learned societies * to obtain information as to which studies and activities should be pursued by students desiring to prepare themselves for the various professions.

In this respect the courses in engineering have not been neglected as witnessed by the many studies devoted to the subject, including the five year survey conducted by the "Society for the Promotion of Engineering Education."

The subject of engineering education has claimed the interest of the present writer for a number of years and the result of his study, particularly as applied to electrical engineering, has resulted in evolving courses which differ radically from those usually offered by educational institutions, or arrived at as more or less ideal by some of the extended surveys.

These courses herein described, although unique as compared with the standard courses, were arrived at by the same principles of pedagogy, psychology, economics and educational philosophy which have been reiterated by many educators, including some who have seemed to find it difficult to carry over their sound theoretical principles into the field of practical application.

The course of studies described in this paper would not be submitted at this time were it not for the fact that, in much the same form as herein given, they have proved most successful both in their practicability in administering and pres-

* For example: Franklin Babbitt, Charles H. Judd, J. J. Hammond, The Society for the Promotion of Engineering Education, etc.

entation and in the success of their graduates, as shown by the positions of responsibility they have attained, their earning power and their standing in the profession.

Some of the principles of curriculum construction have been so often stressed as to require no mention here and, on the other hand, some fundamental principles of education have been repeatedly overlooked. For this reason, before giving details of studies, it is well to state the basic foundations and viewpoints involved. Some of these principles are general and some have in view a specific application to professional and engineering training:

1. The object of any engineering training or education should be fundamentally the preparing of the student to meet the practical situations of his professional life.

2. If his endeavors are to be devoted to activities in practical fields it is obvious that his training should be practical. This requires that he obtain definite technical knowledge and skill in his field and such academic education as may be necessary to direct his skill intelligently and, when possible, to enable him to add to the amount of total knowledge through observation and research.

3. His training should enable him to function not only as a technician but also to conduct himself properly and to advantage as an individual in his contacts with his fellow workers and other associates.

4. A correct system of education should include from the first such direct or indirect moral training as to enable him to adopt a sound philosophy of life and to be a good citizen.

5. Principles of education are general and are not to be confined to any select group or favored few and, in consequence, policies, methods and curricula should be so framed that somewhere in the educational plan any ambitious man, irrespective of his former educational advantages, should be able to find a place where he will fit himself to increase his knowledge and training, his earning power and his value to the community.

6. A student should be able to receive benefits of an edu-

cational institution even if the time at his disposal is short or if his financial means are limited.

7. For the sake of the individual and for the benefit of society a student should be allowed to progress to the limit of his potentialities.

8. Educational institutions supported by taxpayers' money should be available to the taxpayers and their children, and it is fundamentally wrong to exclude large groups desiring training in order to cater to a few even if they be best favored by finances, background or inherent ability.

9. The raising of a man of lower educational foundation to a higher level may be as great a contribution to the real wealth in a community as to elevate a more highly educated individual to a still higher level.

10. In the construction of a curriculum the objectives are paramount and must be kept constantly in view.*

As regards the specific field of electrical engineering the following facts are worthy of study:

1. In the electrical industry there are demands for men of a wide variety of experience, training, education and ability. Such men are required from those who dig post holes or assemble lamp sockets to the industrial captains, research physicists or a Steinmetz.

2. The young men who desire to enter the electrical industry possess a wide variety of experience, training and education but, what has a tremendously greater bearing on the case, they include individuals of the widest possible variation in inherent ability or potentialities.

3. The time available for education also varies among individuals.

4. From 1, 2 and 3 it follows that there is a need of training and educational systems to fit the wide variety of students, to fill the wide diversity of positions and to offer courses applicable to various lengths of time.

With the above points in view the following curriculum has

* For methods of determining major objectives see "Curriculum Construction," W. W. Charters, the MacMillan Co., N. Y., 1927, pp. 41–55, etc.

been instituted. It consists, primarily, of a course in electrical engineering occupying three full years of twelve months per year, or a total of thirty-six months, which is equivalent to a so-called four year course operating nine months per year. The arrangement of the studies is made on an ascending scale of difficulty and thoroughness with a definite goal or accomplishment each year.

The curriculum in question includes three distinct courses or units:

One year .....Commercial Electrical Engineering,
Two year .....Industrial Electrical Engineering,
Three year .....Electrical Engineering with B.S. Degree.

The complete course follows:

COURSE OF STUDY LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

First Year

Term I

Subjects	Periods per Week
Electric Light and Power Wiring	
Lecture 5, Laboratory 15	20
Electric Metering and Testing	
Lecture 5, Laboratory 15	20
General Electricity	5
Algebra (as needs require)	5

Term II

Direct Current Generators	10
Direct Current Armature Winding	10
College Algebra	5
Commercial English	5
Commercial Engineering (Salesmanship)	5
Drafting	10

Term III

Alternating Current Generators	10
Alternating Current Armature Winding	10
Trigonometry	5
Commercial English	5
Commercial Engineering (Merchandising)	5
Drafting	10

Term IV

Refrigeration, or Radio	20
Analytic Geometry	5
Commercial Law	5
Machine Design	10

When completed, this course entitles the student to a certificate in Commercial Electrical Engineering.

Second Year

Term V

Subjects	Periods per Week
Direct Current Circuits and Magnetism	4
Electrical Laboratory 2, Lecture 2	4
Technical English	4
Advanced Analytic Geometry and Calculus	5
College Physics	4
College Economics	4

Term VI

Direct Current Machinery	4
Electrical Laboratory 3, Lecture 2	5
Differential Calculus	5
Technical English	4
College Physics	3
Industrial Organization and Management	4

Term VII

Alternating Current Circuits	3
Electrical Laboratory 3, Lecture 2	5
Differential and Integral Calculus	5
College Physics	4
Steam Power Plant Engineering	4
Public Utilities, Rates, Appraisals	4

Term VIII

Transformers	3
Electrical Laboratory 3, Lecture 2	5
Integral Calculus	5
General Inorganic Chemistry	8
Electrical Survey and Plant Operation	4

When the course of study is completed to this point, the student is entitled to a certificate in Industrial Electrical Engineering.

Third Year

Term IX

Subjects	Periods per Week
Synchronous Machinery	4
Electrical Laboratory	3
Mechanics	5
Wave Analysis	2
Differential Equations	2
Design of Magnets	4
Qualitative Analysis	5

Term X

Synchronous and Induction Machines	4
Electrical Laboratory	3
Mechanics	5
Thermodynamics	3
Design of Transformers	5
Gravimetric Analysis	5

Term XI

Advanced Direct Current Circuits and Magnetism	5
Electrical Laboratory 3, Lecture 2	5
Design of Sub-stations	7
Thermodynamics	3
Volumetric and Industrial Analysis	5

Term XII

Advanced Alternating Currents and Transmission	5
Electrical Laboratory 3, Lecture 2	5
Electrochemistry	6
Engineering Law	4
Seminar	1
Design of Generators	4
Thesis	

When the curriculum is completed to this point, the student is entitled to the degree of Bachelor of Science in Electrical Engineering.

Entrance Requirements

The entrance requirements of the above courses are:

Entrance to first year:

1. High school graduation from a course including algebra, geometry and physics, or

2. Equivalent preparation and studies which are provided and offered to the students who are deficient in requirement 1.

Entrance to second year:

Satisfactory completion of the first year.

Entrance to third year:

Satisfactory completion of the second year.

The value of the above curriculum may be analyzed from three angles:

1. The student who completes the entire course.
2. The student who commences the course but does not complete the entire schedule.
3. The young man who contemplates a course but feels he cannot spend four years in his preparation or, perhaps is fearful of his ability to carry advanced subjects.

Regarding the first class, we have available information as to the number of students who complete this course and other engineering courses in the various colleges and universities.

In regard to the second class various colleges and surveys show that about 50 per cent of the students who enter electrical engineering courses never reach the third, or junior, year and these same 50 per cent have spent up to two years and have little or no electrical knowledge. In many cases they were dismissed from electrical courses due to deficiency in studies having no bearing on electrical subjects and requiring an entirely different mental equipment. Also, a recent survey of the Society for the Promotion of Engineering Education shows graduation on the part of only 28 per cent of the students enrolled in the freshman year.

As to the third group, we have no knowledge of the number of students who would be glad of an opportunity to pursue shorter courses with definite aims who are denied the privilege.

For the students who are in the first classification, or those who finish the entire course for a B.S. degree, the curriculum appears sound. In the first place they have the ad-

vantage of a graded course wherein the students start with simple conceptions of electricity, gradually building to more detailed and theoretical conceptions of principles and their applications. Each unit advances them in ability to do definite things and gives them an added sense of power which serves as an inspiration to further advance.

Being in contact with electrical subjects they not only have the advantage gained in learning by doing, but have a definite incentive to study theory as they progress in the practical work and the need of a knowledge of theory is evident. The educational advantage to the student of having a definite objective is obvious.

As to the progressive method of presentation, we can illustrate this by comparison with the methods usually used and results obtained in teaching a foreign language in our high schools.

When a child learns to speak his native language he first learns names of things and associates each object with the word which identifies it. He learns simple verbs as applied to actions which he experiences. Later refinements appear and his discrimination advances, to meet which condition the need of adjectives and adverbs is realized. Having a vocabulary simple sentence structure is learned; then the teaching of elementary grammar becomes logical and, finally, elegance as well as correctness is acquired through the study of rhetoric.

No sane parent begins to teach a child to talk by having him memorize rules of grammar or to conjugate verbs. That comes later. To-day even the memorizing of the alphabet is not considered an initial step in education.

The child placed in a foreign language speaking household learns in a short time to converse in that language because he builds his knowledge upon simple needs and he has a direct objective in learning additional facts so that he may better express himself and understand others.

In many of our schools the old "Preparation" idea still prevails. A language is taught by learning rules, declining nouns and sing-songing verbs, regular and irregular, through

indicative and subjunctive and what-not until, by comparison, "Jabberwocky" becomes a model of simplicity to the understanding.

The result of such study is best understood by asking an average high school graduate of four years' experience in Latin to carry on a simple conversation in that language. This situation has been pointed out many times and even many years ago.*

The same logic applies to the teaching of electricity. The natural way to teach is, first, to give elementary knowledge; then emphasize the facts and cause them to be retained by having the student perform experiments and verify simple facts; then, gradually, build upon these solid foundations until complicated and advanced theory may be mastered.

It is also a well known theory of education that no instructor can teach anything to a student direct, but the student teaches himself and the instructor functions as a guide for and inspiration to his mental efforts. The learning on the part of the student requires not only a mental effort on his own part but his knowledge comes only as new facts can be interpreted by means of his former experiences and knowledge. The practical work of the first year supplies much of this experience. In this work the student speaks the language and thinks the thoughts of the engineer and of the electrical industry. This familiarity with the subjects, together with his practical knowledge, is a most excellent background for a higher education, should he remain to advance beyond the first year's training.

In addition to any other fact it is unquestionable that, if properly presented, the student acquires more electrical knowledge by studying electricity thirty-six months than he

* For instance, "Camp followers and military attendants engaged in the kitchen and in other menial occupations learn a tongue different from their own, sometimes two or three, quicker than the children in the schools learn Latin only, though children have an abundance of time and devote all their energies to it, and with what different progress."

"All languages are easier to learn by practice than by rules." John Amos Comenius, London, A. & C. Black, Ltd., 1923, pp. 79, 206.

could possibly obtain in eighteen months. The direct method of teaching electricity is to teach electricity.

The skill displayed in actual experience in the first year, together with his success in the academic subjects pursued, gives the student a chance to discover early in his course whether or not he is interested in the training or the field of endeavor. This affords a real service in vocational guidance, a subject which is receiving much attention from many capable and also from many highly visionary writers.

It is to be remembered that, while the course is a practical one, the student who completes the schedule actually receives a larger amount of theory than usually given but has a better chance to know what it means. Experienced instructors feel that the students in these upper terms are exceptionally able to grasp the theory with very satisfactory rapidity and thoroughness.

To the students of the second group, which are those who do not complete the course in its entirety, the curriculum is especially valuable. Incidentally, in most colleges this includes the largest per cent of students who enroll.

Should the student leave after six months, a year, or after two years, he has a definite preparation for a definite industrial usefulness. As he remains longer he acquires a higher industrial level. He takes no chances in his educational investment as he need not reach a senior year, or finish a long course, to obtain a return for his time and funds. His leaving time is determined when he has found his level of educational potentialities, or as other circumstances dictate. At the end of the first six months he is useful as an electrician; at the end of the first year he is desirable for being trained in practical electricity and salesmanship and also has a year of college mathematics as a background.

The second year of the course is designed to meet the demands of the industry for men trained for certain requirements of public utilities, plant operators and in similar positions where a complete college course is not required, and to offer a definite objective as a goal for the students who have

at their disposal more than one year but have not the opportunity to finish a complete course for a degree. At the end of the second year they have a mathematical training through calculus.

To the third group in our classification, or the thousands of ambitious young men who do not approach a college course because of its length, entrance requirements or difficulties, the present curriculum welcomes them to come for as long as they may, assuring them added earning power, cultural as well as practical advantages and, however long they remain, their training contributes to society an added economic value.

Subject Matter and Administration

The selection of subject matter was made through much correspondence, many interviews with electrical engineers, educators, public utility operators and others and some reflection on the subject of human nature.

One fact is to be noted, namely: that the training is for the electrical industry; hence economics, electric surveys, salesmanship, etc., are given prominent places.

In the presentation of the various subjects many opportunities offer themselves to contribute much of value to the student by keeping in mind orientation and morals.

The first is accomplished by pointing out industrial methods needs and opportunities and by methods of presentation; the second by indirect moral training.

As to administering the plan much may be written but probably one of the most important features lies in the fact that it has been found desirable to assign some of the most experienced and competent instructors to the freshman classes, thereby laying a good foundation, furnishing inspiration and giving the greatest possible number of students the benefit of their ability. The recent graduate is usually not as competent to teach freshmen as to instruct those in higher grades.

While there is a temptation to confine attentions to the exceptional student to develop a superior product, nevertheless colleges and universities are under a moral obligation to limit

their executive prerogative, and reflect that the institutions are public servants and, as such, if they are to justify themselves must carry the viewpoint of "service" uppermost.

Changing conditions and requirements demand that there be a constant attention paid to the question of curriculum construction in professional courses, and we must realize that study and progress must supersede prestige and inflexible conventions.

EMPLOYMENT SERVICE

The Secretary on February 24 wrote to the administrative heads of all engineering schools in the United States and in Canada asking them to notify this office if they expected to have any vacancies on their staffs. In the March JOURNAL OF ENGINEERING EDUCATION, we called the attention of the members to this employment service which the Society was inaugurating.

At this writing, May 12, twenty-five vacancies have been listed. Fifty-nine members have notified us of their desire to change their positions.

ERRATA

On page 757, March JOURNAL, Ralph W. Sorensen should be Royal W. Sorensen.

On page 773, the last paragraph should be separated from the preceding one and should read "Curves found on pages 760 to 766, inclusive . . ."

F. L. BISHOP,
Editor.

LETTER TO THE SECRETARY

March 14, 1930

PROFESSOR F. L. BISHOP, *Secy.*,
Society for Promotion of Eng'g Education,
University of Pittsburgh,
Pittsburgh, Pennsylvania.

Dear Professor Bishop:

In the last few years a situation has come to exist which should be of grave concern to the profession of engineering education. In what follows I have attempted to outline this situation and to suggest a remedy.

Engineering teachers make engineering graduates who in turn make industry. Let us examine the present practice and methods of making engineering teachers who make engineering graduates, who make INDUSTRY. The examination is very simple: there are no methods. INDUSTRY has developed such efficient methods of absorbing the engineering graduate that seldom, or at best only by accident, is any material left, out of which to make engineering teachers. Just how long the snake can eat its own tail and get away with it; just when it is desirable to kill the goose that lays the golden egg are questions to wonder about. INDUSTRY can hardly be expected to assume any responsibility in the matter. Whose responsibility is it? Maybe some society interested in the promotion of engineering education should assume the responsibility. How should the recruiting be done? May I suggest a remedy.

The S. P. E. E. should act as a clearing house and receive from the hundred and more engineering schools a numerical statement of approximately how many engineering assistants and instructors are needed for the ensuing year. Armed with this information a delegation, appointed and financed by the S. P. E. E., should make the rounds of the engineering schools, hold scheduled interviews with the members of the

graduating classes, sell the proposition to desirable and appropriate candidates, and finally offer specific positions, subject of course to final approval of the parties concerned.

Idealistic and impractical as the remedy may be, it is no reason for our Society evading the whole responsibility. It is to be hoped that the issue will soon be faced.

Yours very sincerely,

LEONARD A. DOGGETT,
Professor of Electrical Engineering.

Purdue Branch.—Over one hundred members of the Purdue University teaching staff attended the January 7 meeting of the Local branch of the S. P. E. E.

The subject of discussion was "Is Our Grading System Satisfactory?" The affirmative side of the question was taken by Professor R. B. Wiley, Civil Engineering, and Professor T. E. Mason, Mathematics. The speakers for the negative were Professor R. G. Dukes, Applied Mechanics, and Professor J. D. Hoffman, Practical Mechanics.

In general, grades of students at Purdue are based on an absolute standard of minimum essentials set up by those in charge of each subject. A student who fulfills all the minimum essentials only, receives a passing grade of "P." A grade of "B," passed with merit, is given if the student presents somewhat more than the minimum essential required by the instructor for credit in the course. The grade of "A" is given to the student passed with honor, but who does not necessarily show exceptional proficiency. The fourth passing grade "H," is given to those of outstanding ability whose work is of such exceptional character as to merit special recognition. An additional requirement for graduation is that a student must secure a grade of "B" or better in at least 90 semester hours of credit.

This system of grading is based upon minimum essentials superceded the percentage scale which was in use at Purdue University until recently.

A careful study of the old percentage system brought out quite plainly that grades were neither reliable nor comparable. There was no common standard of grading. Different instructors used the same passing grade to designate different degrees of capacity and ability thus destroying both the reliability and comparability of all grades.

The method of computing a student's percentage grade, even if based on a carefully worked out standard, was inaccurate because it was a measure of the student's total performance and not of final accomplishment or attainment at the end of the course. If, in the early part of the semester, a

student received 40 per cent on a certain important exercise, that 40 per cent was, under the rule, averaged with other grades to obtain the semester grade even though the student might later have attained an almost perfect knowledge of the subject matter on which the original exercise was based. The final grade, therefore, could not represent attainment.

The present system, if followed conscientiously, eliminates many of the bad features of the percentage scheme. The system of minimum essentials sets up a quantitative definition of a passing grade in terms of jobs to be done. The satisfactory performance of each job represents a certain degree of attainment. The attainment acquired in the completion of the required number of jobs represents a passing "knowledge of and ability to think in the material of the course" and hence merits a passing grade."

If the minimum essentials in a course are set up with due consideration to the credit hours allowed and the profundity of the subject matter the inequalities in the amount of the student's time required per credit hour would be considerably reduced.

The main objections to the idea of minimum essentials, as voiced by the speakers on negative side of the discussion, arise from the difficulty of setting them up and in determining just what degree of attainment in each one is acceptable. Both are admittedly difficult and require a great deal of work and good judgment on the part of the instructor. Unless the normal curve or grade distribution method of grading students, in which the instructor merely rates the students in order, the judgment of the instructor will always be the important factor in grading. Where this is so every means possible should be employed to assist him in exercising his judgment and the processes should be simplified and not complicated.

The determination of grades above passing is comparatively simple. The "P" grade is given to students who meet the minimum essentials and no more, and it is not difficult to separate this group. The "H" grade is given to a very few outstanding students who are easily recognized. The remain-

ing group is then to be divided into "A" and "B" on the basis of exceptional proficiency of the "A" group.

The whole idea of minimum essentials was developed in order to insure that the student has accurate knowledge of the important things to be gained whether that knowledge was gained through one or several trials.

A questionnaire prepared by Professor J. D. Hoffman, one of those defending the negative side of the discussion, showed the following results in 200 replies:

1. Practically all instructors keep some sort of grade record for each student.

2. 61 per cent use the numerical system or equivalent for their daily work with the letter final grade. 39 per cent use the letter grades only.

3. 51 per cent record a grade for each recitation or job satisfactorily done. 41 per cent record grades frequently but not regularly. 8 per cent make infrequent records.

4. About 50 per cent apparently grade only on work done, and 50 per cent report grades plus attitude toward the work, general impressions, etc.

5. 75 per cent take account of the improvement in the student's work, or the reverse, as the semester progresses and this is used to modify the semester's grade for the final report.

The general consensus seemed to be that there is no inflexible rule of grading and no possibility of all instructors grading exactly alike under any system; that there should be a common standard for grading in all departments, that the present system of grading seems to have a very marked effect in bringing about a condition whereby the teacher considers not only the actual grades made by the student but also tries to find out all he can about the student and his general knowledge of the subject.

While some, who entered into the discussion, felt that in their courses the idea of minimum essentials can not be used absolutely, every effort seems to be made to study seriously the whole problem of student grades.

M. W. TODD,
Secretary.

COLLEGE NOTES

Missouri School of Mines.—Daniel C. Jackling, of San Francisco, Calif., President of the Utah Copper Company, has made provision for the establishment at the Missouri School of Mines and Metallurgy at Rolla, of which he is a graduate of the class of 1892, of the Jackling Foundation for education in the sciences and arts pertaining to the mineral industry, the purpose of the Foundation being to aid worthy students through school by means of generous loan funds and to provide scholarships and special educational features not ordinarily provided for at state schools.

The Foundation, through contributions already made and to be made by Mr. Jackling, may eventually total $600,000. Of this amount one hundred thousand dollars is to be used as loan funds and the income from five hundred thousand dollars will be used for scholarships and special educational purposes. About twenty years ago Jackling established the Jackling Loan Fund at the School of Mines, which fund has already helped over three hundred students through the school.

In establishing the Foundation, Jackling specifically requests that the income from it be used in no way that will lessen the support the school is to receive from the State, expressing it as his conviction that the state is indebted to a state school for sufficient funds for operation.

BOOK REVIEW

Mechanical Engineering Laboratory Practice. By CHARLES F. SHOOP AND GEORGE L. TUVE. McGraw-Hill, 1930. 488 pages. $4.00.

This work is designed for a laboratory course covering seventy experiments ranging from simple calibration tests of instruments to efficiency trials of complete power plants. The principal types of tests covered are: weighing and measuring instruments, indicators, hand hoists, valve setting, lubricants, pumps and compressors, boilers, engines, turbines, governors and internal combustion engines.

Each experiment is outlined in some detail, special care being taken to point out precautions to be taken and errors which may occur. Forms are in most cases shown for the preparation of reports. The various types of apparatus are well illustrated and described. Little of the underlying theory is included, the student being referred for this to other standard reference works. Several of the exercises are of the nature of visits to commercial plants, the student being instructed what to look for, and what to include in his report.

An appendix gives tables of conventional abbreviations, conversion factors, standard dimensions of pipes, etc., thermodynamic formulas, properties of various materials, etc.

This book is quite comprehensive and well arranged for instruction purposes. It should serve as an excellent text for laboratory courses. By judicious selection of experiments it could be used equally well for the most elementary or for advanced undergraduate work, for long or short courses. Altogether it presents a useful and commendable piece of work.

J. A. D.